

5. The interlobar veins and the subcortical veins are furnished with bicuspid valves, guarding points of confluence.
The position of the kidney of the giraffe in the system of kidneys with collateral recesses being discussed.

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Breeding of the Lowland Anoa, *Bubalus (Anoa) d. depressicornis* (H. SMITH, 1827) in the San Diego Zoological Garden

By JAMES M. DOLAN jun.

Eingang des Ms. 24. 7. 1964

Among those mammals which were formerly met with in most large zoological gardens, is the little wild ox of Celebes (Suwalesi), the Anoa, *Bubalus (Anoa) depressicornis*. As is the case with a number of mammalian forms that were at one time comparatively common in zoological collections, the Anoa has now become an extremely rare and valuable exhibit. This small ox, like its other asiatic relatives, is now threatened with extinction.

Confined to the Island Celebes, the Anoa has been divided into three subspecies: the Lowland Anoa, *Bubalus (Anoa) d. depressicornis* (H. SMITH, 1827); the Mountain

Anoa, *Bubalus (Anoa) d. fergusonii* (LYDEKKER, 1905) and Quarles' Anoa, *Bubalus (Anoa) d. quarlesi* (OUWENS, 1911).

As far as can be ascertained through paleontological investigation these cattle developed as insular forms, being unknown on the asiatic mainland. Previously the Anoa were treated as representing a genus distinct from the remaining asiatic water buffalo. However, BOHLKEN 1958) was able to demonstrate that these animals do not possess characteristics justifying generic distinction. Therefore, they are now to be considered as merely representing a distinct species with three subspecies.

The Lowland Anoa reaches a shoulder height of about 98 cm, while the two remaining forms are a good deal smaller: Mountain Anoa 76 cm: Quarles' Anoa 62,5 cm. The typical animal is short legged and heavy bodied, the tail reaching almost to the hocks. Calves are covered with a woolly brown coat (Fig. 1), the adult pelage ranging from dark brown to black. In many cases, the animals can be almost hairless. White areas are to be found above the eye lids as well as directly posterior to the eye, on the lower jaw, the neck, the legs, the rear portion of the neck, and the inner surface of the ears (Fig. 2). The size and presence of these white areas varies considerably with individual animals. The horns reach a length of up to $15\frac{3}{8}$ inches (39 cm) which is the record length held by an animal in the Museum National d'Histoire Naturelle, Paris (WARD, 1954). They are lightly ringed, triangular at their bases, in an almost straight line, directed upwards and outwards nearly in the plane of the face. It is the triangularly compressed horn form which has given this animal its specific name, *depressicornis*.

As previously stated the Mountain Anoa, *Bubalus (Anoa) d. fergusonii* is a smaller animal than the nominate form, with shorter horns and a woolly golden-brown coat. The inner surfaces of the ears are clothed with dark hairs. There are white markings on the legs and face and the tail is shorter than in *depressicornis*.

Quarles' Anoa, *Bubalus (Anoa) d.*



Fig. 1 (left): Lowland Anoa calf, *Bubalus (Anoa) d. depressicornis*, no. 16, San Diego 25 "Banda". (Photo: Zoological Society of San Diego)

Fig. 2 (right): Lowland Anoa showing the white facial markings. Bull. no. 3, San Diego 12, "Sumatra". (Photo: Zoological Society of San Diego)

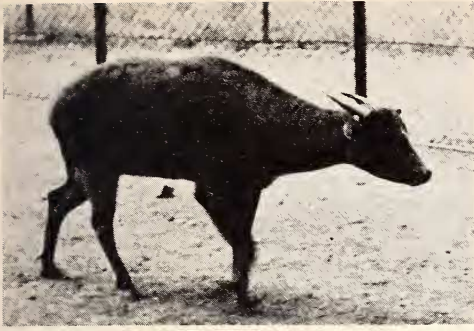


Fig. 3. Quarles' Anoa, *Bubalus (Anoa) d. quarlesi* in the Amsterdam Zoological Garden. (Photo: C. S. Koor, 17. Juli 1944)

quarlesi (Fig. 3), the smallest of the Anoas, is light brown with white spots only above the hoofs, the tail not extending more than halfway to the hocks. As in *fergusoni*, the inner surfaces of the ears are clothed with dark hairs. Unlike the two previous subspecies, the horns are not triangular, but rather conical in form (OUWENS, 1910).

Unfortunately, there has been a great deal of confusion as to the identification of animals brought from Celebes, particularly in the case of the Mountain and Quarles' Anoas. The validity of *Bubalus (Anoa) d. quarlesi* has often been questioned. HARPER

(1945) has treated it as synonymous with *fergusoni* whereas BOHLKEN (1958) has retained it as a valid subspecies. In a description of both the Mountain and Quarles' Anoas it can be seen that the differences are not very great and when one considers the amount of variation in the white markings within a population of *Bubalus (Anoa) d. depressicornis*, these differences may prove nonexistent. However, until such time as a thorough study of this problem can be undertaken the name *quarlesi* must be retained as valid. HERWART BOHLKEN (1958) in his comprehensive study of the wild cattle was unable to gather sufficient material and my own inquiries have proven just as unsuccessful.

The Anoas, unlike their larger relatives are solitary and rarely, if ever, found in herds. Generally they are to be met singularly or in pairs.

At the end of the 19th century, the Lowland Anoa enjoyed a rather wide distribution throughout northern Celebes. In the year 1937 it was still fairly common in the forested areas in Gorontalo, northern Celebes (HARPER, 1945). However, since that time there have been considerable changes in the area, so that regions which once provided habitat for this animal are now under cultivation. As a result the Lowland Anoa is now found as a severely threatened remnant only sporadically in the swampy forests of northern Celebes.

The Mountain Anoa of Central and Southeastern Celebes and Quarles' Anoa of South Celebes (MOHR, 1921) both seem to have fared somewhat better than the larger form due to the mountainous terrain which they inhabit. However, both of these subspecies are also nearing extinction as there has been little effective game protection since the Dutch departed from Indonesia.

Due to its viciousness, the Lowland Anoa was but rarely hunted by the natives of Celebes prior to the introduction of firearms. HEYNSIUS-VIRULY and VAN HEURN (1936) report that the Anoa is an extremely dangerous quarry when wounded. Experiences with these animals in captivity help to substantiate their reputation. An Anoa bull, formerly in the Melbourne Zoological Garden, not only killed his cow and calf, but also made several attempts on the life of his keeper (OSBORN). At the turn of the century, the Duke of Bedford kept a pair of Anoas free in Woburn Park, but it eventually became necessary to confine them after they attacked and killed a number of park deer. At the Catskill Game Farm, Catskill, New York, an Anoa bull killed a cow with which he had peacefully lived for some time. Because of their disposition, Anoas require careful observation in captivity. Under no circumstances should more than one bull be kept in an enclosure and we have found it advisable to remove the breeding bull after all of the cows have been serviced. In this respect

cow Anoa do not greatly differ from the males and are particularly dangerous when they have calves.

The first Anoa, two cows, exhibited in San Diego arrived on March 30, 1925, from the Honolulu Zoological Garden. Their history here was of a short duration, the first cow dying on September 30, 1926, when about sixteen years old, the remaining animal being sent to Washington, D. C. on December 12, 1926. This latter animal was known to be in her sixth year at the time of sale. It was not until August 23, 1937, that these cattle were again represented in the collection. This pair were obtained from the Surabaya Zoological Garden in an exchange, followed by an additional pair on August 11, 1941, again from Surabaya. Unfortunately, the older records have been poorly kept, which has been the case with most zoological gardens, so that there are a few vague points. However, I have been able, after closely studying the records to establish all birth dates excepting four. The following calves have been born in the San Diego Zoological Garden:

March 13, 1942 — bull; March 1944 — bull; March 10, 1945 — bull — died December 14, 1951; Feb. 28, 1946 — cow — sent to Pittsburgh on May 20, 1948; May 20, 1946 — bull — sent to Pittsburgh on May 20, 1948; Feb. 19, 1947 — bull — sent to Catskill Game Farm; May 7, 1947 — cow — sent to Pittsburgh on May 20, 1948; Feb. 18, 1948 — cow — sent to Pittsburgh on May 20, 1949; March 5, 1951 — cow — retained in San Diego; March 20, 1951 — bull — retained in San Diego; May 9, 1952 — bull — sent to Washington, D. C. in June 1954; Nov. 19, 1953 — cow — sent to Washington, D. C. in June 1954; Nov. 8, 1954 — sex and disposition unrecorded; Oct. 13, 1955 — still born, sex unrecorded; April 2, 1956 — stillborn, sex unrecorded; May 6, 1957 — stillborn — bull; 1958 — bull — retained in San Diego; April 27, 1959 — bull — sent to Berlin (West) on June 12, 1962; June 11, 1960 — cow — retained in San Diego; July 17, 1961 — cow — retained in San Diego; July 6, 1962 — cow — died July 8, 1962; July 23, 1963 — cow — died September 7, 1964; Nov. 6, 1964 — cow — retained in San Diego.



Fig. 4. Lowland Anoa cow, no 1 Surabaya D.
(Photo: Lincoln Park Zoo)

Prior to 1945 two cow calves were born in the collection, however it is not possible to give the birth dates for these animals. Further gaps in the records are to be found for the years 1949 and 1950, although it is known that calves were produced in those years. The present San Diego herd consists of six animals, two bulls and four cows, all born in the garden. Of the 26 anoa produced in the San Diego Zoological Garden, eight have been sold to other collections.

The Anoa pair obtained from the Surabaya Zoo in 1941 were exchanged with the



Fig. 5. Lowland Anoa: left female no. 13, San Diego 22 "Buru", center female no. 3, San Diego 11 "Java", right female no. 15, San Diego 24 — died 7 September 1964. (Photo: Zoological Society of San Diego)

Lincoln Park Zoo, Chicago, in 1943 for a pair of Guanacos. The cow of the 1937 pair died on June 30, 1955, the bull following on September 23, 1955.

Of the twenty-two births which have been accurately recorded, calving has taken place in the following months: 5 in March, 4 in May, 3 in February, 3 in July, 2 in April, 3 in November, 1 in June and 1 in October.

Since the Anoa is now extremely rare in captivity and verging on extinction in Indonesia, it has been deemed advisable to establish a stud-book so that a close check can be kept on the remaining captive animals. This has been undertaken on behalf of the International Union for the Conservation of Nature and Natural Resources and its Survival Service Commission. I am particularly grateful to the following colleagues for their cooperation: Miss CAROLINE JARVIS, London; Miss GRACE DAVALL, New York; Dr. HEINZ HECK, Catskill; Sir EDWARD HALLSTROM, Sydney; Mr. HOWARD HAYES, Pittsburgh; Mr. GENE HARTZ, Chicago; Mr. LEAR GRIMMER, Washington; and Mr. ED. MARUSKA, Cincinnati.

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Official Register of all Lowland Anoa, *Bubalus (Anoa) d. depressicornis* living in captivity as of 31 XII 1964

Number	Sex	Studbook Number	House Name	Born	Father	Mother	Location
15	F	San Diego 11	"Java"	5 III 51			5 III 51 San Diego
16	M	San Diego 12	"Sumatra"	20 V 51			20 V 51 San Diego
23	M	San Diego 19	"Bali"	1958	16 San Diego 2	15 San Diego 11	1958 San Diego
25	F	San Diego 21	"Sula"	11 VI 60	16 San Diego 12	15 San Diego 11	11 VI 60 San Diego
26	F	San Diego 22	"Buru"	17 VI 61	16 San Diego 12	15 San Diego 11	17 VI 61 San Diego
29	F	San Diego 25	"Banda"	6 XI 64	16 San Diego 12	15 San Diego 11	6 XI 64 San Diego
17	M	San Diego 13		9 V 52			9 V 52 San Diego 24 VI 54 Washington
18	F	San Diego 14		19 XI 53			19 XI 53 San Diego 24 VI 54 Washington
32	M	Washington 3		4 V 58	17 San Diego 13	18 San Diego 14	4 V 58 Washington 6 X 59 Catskill 11 XII 64 Cincinnati (on loan)
35	M	Pittsburgh 3		5 VI 55	11 San Diego 7	14 San Diego 10	5 VI 55 Pittsburgh 16 VI 57 New York
24	M	San Diego 20		27 IV 59	16 San Diego 12	15 San Diego 11	27 IV 59 San Diego 12 VI 62 Westberlin
41	M	Lincoln Park 1		about 1952	5 Surabaja C	6 Surabaja D	about 1962 Lincoln Park
42	M	Taronga 1					? Taronga Park, Sydney 1 IV 54 Whipsnade 30 I 65 London
44	M	Taronga 3					? Taronga Park, Sydney
45	M	Taronga 4					? Taronga Park, Sydney
46	M	Taronga 5					? Taronga Park, Sydney
47	M	Taronga 6					? Taronga Park, Sydney
48	F	Taronga 7					? Taronga Park, Sydney
49	F	Taronga 8					? Taronga Park, Sydney

Number	Sex	Stadbook Number	House Name	Born	Died	Father	Mother	Location
1	F	Honolulu 1		1910 ?	30 IX 26			30 III 25 San Diego
2	F	Honolulu 2		1920	?			30 III 25 San Diego
3	M	Surabaja A		1935	23 IX 55			12 XII 26 Washington
4	F	Surabaja B		1935	30 VI 55			23 VIII 37 San Diego
5	M	Surabaja C		about 1940	?			11 VIII 41 San Diego
6	F	Surabaja D		about 1940	20 XII 64			7 VI 43 Lincoln Park Chicago
7	M	San Diego 2		13 III 42	?	3 Surabaja A	4 Surabaja B	11 VII 41 San Diego
8	M	San Diego 4		III 44	?	3 Surabaja A	4 Surabaja B	7 VI 43 Lincoln Park
9	M	San Diego 5		10 III 45	14 XII 51	3 Surabaja A	4 Surabaja B	13 III 42 San Diego
10	F	San Diego 6		28 II 46	20 V 47	3 Surabaja A	4 Surabaja B	10 III 45 San Diego
11	M	San Diego 7		20 V 46	1957	3 Surabaja A	?	28 II 46 San Diego
12	M	San Diego 8		19 II 47	?	3 Surabaja A	4 Surabaja B	20 V 47 Pittsburgh 20 V 46 San Diego
13	F	San Diego 9		7 V 47	1961	3 Surabaja A	?	20 V 47 Pittsburgh 1948 Catskill Game Farm
14	F	San Diego 10		18 II 48	1963	?	?	7 V 47 San Diego 25 V 48 Pittsburgh
15	F	San Diego 11	"Java"	5 III 51		?	?	18 II 48 San Diego
16	M	San Diego 12	"Sumatra"	20 V 51		?	?	25 V 49 Pittsburgh
17	M	San Diego 13		9 V 52		?	?	1961 Catskill Game Farm
18	F	San Diego 14		19 XI 53		?	?	5 III 51 San Diego 20 V 51 San Diego
19	?	San Diego 15		8 XI 54	?	?	?	9 V 52 San Diego 24 VI 54 Washington
20	?	San Diego 16		13 X 55	13 X 55	?	?	19 XI 53 San Diego 24 VI 54 Washington
21	?	San Diego 17		2 IV 56	2 IV 56	?	?	8 XI 54 San Diego
22	M	San Diego 18		6 V 57	6 V 57	?	?	13 X 55 San Diego
23	M	San Diego 19	"Bali"	1958	6 V 57	16 San Diego 12	15 San Diego 11	2 IV 56 San Diego
24	M	San Diego 20		27 IV 59		16 San Diego 12	15 San Diego 11	6 V 57 San Diego 1958 San Diego 27 IV 59 San Diego 12 VI 62 Westberlin

Number	Sex	Studbook Number	House Name	Born	Died	Father	Mother	Location
25	F	San Diego 21	"Sula"	11 VI 60		16 San Diego 12	15 San Diego 11	11 VI 60 San Diego
26	F	San Diego 22	"Puru"	17 VI 61		16 San Diego 12	15 San Diego 11	17 VI 61 San Diego
27	F	San Diego 23		6 VI 62	8 VII 62	16 San Diego 12	15 San Diego 11	6 VI 62 San Diego
28	F	San Diego 24		23 VII 63	7 IX 64	16 San Diego 12	15 San Diego 11	23 VII 63 San Diego
29	F	San Diego 25	"Banda"	6 XI 64		16 San Diego 12	15 San Diego 11	6 XI 64 San Diego
30	?	Washington 1		4 X 55	11 II 56	17 San Diego 13	18 San Diego 14	4 X 55 Washington
31	F	Washington 2		12 IX 56	16 XII 64	17 San Diego 13	18 San Diego 14	12 IX 56 Washington 14 III 58 Cincinnati
32	M	Washington 3		4 V 58		17 San Diego 13	18 San Diego 14	4 V 58 Washington 6 X 59 Catskill Game Farm 11 XII 64 Cincinnati
33	M	Pittsburgh 1		6 XI 51	?	11 San Diego 7	14 San Diego 10	(On loan from Catskill) 6 XI 51 Pittsburgh 1959 Catskill
34	M	Pittsburgh 2		19 I 54	5 VIII 64	11 San Diego 7	14 San Diego 10	19 I 54 Pittsburgh 1955 Cincinnati
35	M	Pittsburgh 3		5 VI 55		11 San Diego 7	14 San Diego 10	5 VI 55 Pittsburgh 16 VI 57 New York
36	?	Pittsburgh 4		5 I 56	5 I 56	11 San Diego 7	14 San Diego 10	5 I 56 Pittsburgh
37	?	Pittsburgh 5		9 IX 56	9 IX 56	11 San Diego 7	13 San Diego 9	9 IX 56 Pittsburgh
38	F	Pittsburgh 6		27 IX 56	?	11 San Diego 7	?	27 IX 56 Pittsburgh 16 VI 57 New York
39	F	Pittsburgh 7		23 XII 56	?	11 San Diego 7	13 San Diego 9	23 XII 56 Pittsburgh 14 X 57 Cincinnati
40	M	Cincinnati 1		15 XI 62	15 XI 62	34 Pittsburgh 2	31 Washington 2	15 XI 62 Cincinnati about 1952 Lincoln Park
41	M	Lincoln Park 1		about 1952		5 Surabaja C	6 Surabaja D	? Taronga Park, Sydney
42	M	Taronga 1						1 IV 54 Whipsnade 30 I 64 London
43	F	Taronga 2			?			? Taronga Park, Sydney 1 IV 54 Whipsnade
44	M	Taronga 3						? Taronga Park, Sydney
45	M	Taronga 4						? Taronga Park, Sydney
46	M	Taronga 5						? Taronga Park, Sydney
47	M	Taronga 6						? Taronga Park, Sydney
48	F	Taronga 7						? Taronga Park, Sydney
49	F	Taronga 8						? Taronga Park, Sydney